MLCPAC STANDARD SPECIFICATION 074
WELDING AND ALLIED PROCESSES

1 SCOPE

1.1 This specification provides requirements and guidance for the performance of all welding and allied processes on Coast Guard cutters and boats.

2 REFERENCES

Coast Guard Drawings: None

Enclosed Figures: None

Applicable Documents:

American Welding Society, ANSI/ AWS D3.7-1990; Guide for Aluminum Hull Welding
American Welding Society, ANSI/ AWS Z49.1-1999; Safety in Welding, Cutting, and Allied Processes
American Welding Society, AWS B2.1-2000; Specification for Welding Procedure and Performance Qualification
American Welding Society, AWS D10.12-2000; Recommended Practices and Procedures for Welding Low Carbon Steel Pipe
American Welding Society, AWS D3.5-2000; Guide for Steel Hull Welding
Code of Federal Regulations, Title 29, Part 1910 (29 CFR 1910); Occupational Safety and Health Standards
Code of Federal Regulations, Title 29, Part 1915 (29 CFR 1915); Occupational Safety and Health Standards for Shipyard Employment
National Fire Protection Association (NFPA) Standards 51B, 306, and 312
Naval Education and Training publication, NAVEDTRA 43119 (Series) Personnel Qualification Standard for Damage Control
NAVSEA 0900-LP-001-7000; Fabrication and Inspection of Brazed Piping Systems
NAVSEA 0900-LP-060-4010; Fabrication, Welding, and Inspection of Metal Boat and Craft Hulls
NAVSEA S0300-BB-MAN-010; U.S. Navy Underwater Cutting and Welding Manual 0910-LP-111-3300, (1 June 2002)
NAVSEA Tech Pub S9074-AQ-GIB-010/248; Requirements for Welding and Brazing Procedure and Performance Qualification
NAVSEA Tech Pub S9074-AR-GIB-010/278; Requirements for Fabrication Welding and Inspection, Casting Inspection, and Repairs for Machinery, Piping, and Pressure Vessels
MIL-C-24576A; Cloth, Silica Glass; Cloth, Coated, Glass, Silicone Rubber Coated (25 July 1978)
MIL-STD-1689A; Fabrication, Welding, and Inspection of Ships Structure Naval Ships' Technical Manual, Chapter 074, Volume 1; Welding and Allied Processes (Jul 98)

3 REQUIREMENTS

3.1 PERSONNEL QUALIFICATIONS - Qualified welders holding a current certification from the U.S. Coast Guard Marine Inspection Office, the American Bureau of Shipping, the American Welding Society, or the U.S. Navy shall accomplish all welding in or on a cutter or boat. All welder certifications shall be in accordance with AWS B2.1 or NAVSEA S9074-AQ-GIB-010/248. Marine Chemists that perform services on Coast Guard cutters or boats shall hold current certification from the National Fire Protection Association in accordance with 29 CFR 1915.

3.2 SAFETY REQUIREMENTS - Comply with the applicable welding safety sections of 29 CFR 1910 and 29 CFR 1915. It is recommended that the Contractor be familiar with the safety precautions of ANSI/AWS Z49.1. Comply with 29 CFR 1910, 29 CFR 1915 for all operations that require gas free certification and require personnel to enter or work in or on confined spaces and encounter hazards, including:

a. Lack of sufficient oxygen to support life

b. Excessive levels of oxygen, which increase the danger of fire or explosions

c. Presence of flammable or explosive atmospheres or materials; and

d. Presence of toxic atmospheres or materials

Because hazards are not always readily apparent, nor detectable by odor or sight, it is imperative to test for hazardous conditions prior to entering confined spaces. In addition, comply with the safety and protective requirements of the following appendices:

3.2.1 Appendix A.1; Fire Prevention and Control of Damage from Welding and Cutting Operations

3.2.2 Appendix A.2; Working with Arc Welding Equipment

3.2.3 Appendix A.3; Working With Oxyfuel Or Inert Gas Welding, Cutting, And Brazing Equipment

3.2.4 Appendix B; Stray Current Protection

3.3 WELDING PROCEDURES

3.3.1 Use electrodes, filler metals, and fluxes in accordance with either:

a. Section 10 of MIL-STD-1689 (for cutters) and Section 10 of NAVSEA 0900-LP-060-4010 (for boats), or

b. Section 2 of AWS D3.5 (steel) and Section 2 of ANSI/AWS D3.7 (aluminum).

3.3.2 Design, prepare, and weld all joints in accordance with either:

a. Section 11 of MIL-STD-1689 (for cutters) and Section 11 of NAVSEA 0900-LP-060-4010 (for boats), or

b. Section 3 of AWS D3.5 (steel) and Sections 3 and 6 of ANSI/AWS D3.7 (aluminum).

3.3.2.1 Design and weld joints in accordance with Section 11 of MIL-STD-1689 and NAVSEA 0900-LP-060-4010 to achieve the required joint efficiencies specified in Tables XVII and 11.1 of MIL-STD-1689 and NAVSEA 0900-LP-060-4010, respectively.

3.3.3 Regulate welding parameters (preheat, heat input, interpass temperatures, and post heat), perform heat treatment, and exercise heat treatment controls in accordance with either:

a. Section 13 of MIL-STD-1689 (cutters) and NAVSEA 0900-LP-060-4010 (boats), or

b. Section 4 of AWS D3.5 (steel) and Section 6 of ANSI/AWS D3.7 (aluminum).

3.3.4 Repairs to existing welds shall be made in accordance with Section 13.17 of MIL-STD-1689 or the applicable section of AWS D3.5 and ANSI/AWS D3.7.

3.3.5 The workmanship requirements specified in Section 14 of MIL-STD-1689 and NAVSEA 0900-LP-060-4010 with respect to weld joint cleanliness and preparation, weld metal deposition, weld contour and cleaning, fillet welds, grinding, peening, and temporary snipes shall apply to all welding procedures on cutters and boats.

3.3.6 Perform all HY-80 welding in accordance with Section 13.5 of MIL-STD-1689.

3.3.7 Perform all pipe welding and inspection in accordance with NAVSEA Tech Pub S9074-AR-GIB-010/278. AWS D10.12 provides additional guidance for welding mild steel pipe.

3.3.8 Perform underwater welding and cutting in accordance with NAVSEA S0300-BB-MAN-010.

3.4 BRAZING PROCEDURES - All joints to be brazed shall be prepared in accordance with NAVSEA Tech Pub S9074-AQ-GIB-010/248. Perform all brazed joint design, brazing procedures, and inspections in accordance with NAVSEA Tech Pub S9074-AQ-GIB-010/248.

3.5 SUPPLEMENTAL REQUIREMENTS - This section provides general guidance with respect to welding requirements on Coast Guard cutters and boats. This information supplements, and in some cases repeats, the requirements specified in the above paragraphs. It is listed here for emphasis and convenience.

3.5.1 The manual shielded metal-arc process may by be used for welding with mild steel electrodes and where joint design will permit sound welds. Other welding processes and filler metals may be used subject to approval of procedure qualifications.

3.5.2 Aluminum welding shall be done using the gas tungsten-arc welding (GTAW/TIG) or gas metal-arc welding (GMAW/MIG) process.

3.5.2.1 Most GMAW equipment can be adjusted for either “continuous” or “weld only” cooling water flow. In humid weather the water flow should not be continuous and should be stopped when welding is stopped. Water vapor from the atmosphere can condense on the gas cup and internal parts of the gun during idle time; the condensate will vaporize and be carried across the arc into the weld, causing weld porosity.

3.5.3 Cut edges of plate shall not have gouges or irregularities unsuitable for welding. These edges shall have slag scale removed by mechanical means before further fabrication or use. Slag and scale shall also be removed from each weld pass or layer before applying additional passes or layers.

3.5.4 Tack welds shall be made with the same grade electrode used in the final weld. Tack welds shall not interfere with the smooth completion of the final weld. Tack welds need not be chipped out provided they are thoroughly cleaned before final welding and found free of cracks or other defects.

3.5.5 Welding shall progress symmetrically to shrink both sides of the structure equally. Intersecting systems of framing and stiffeners are to be welded to each other before they are welded to the plating. Welds are not to be carried across a non-welded joint.

3.5.6 Peening shall not be done on single-pass welds or on the root or cover pass of multi-pass welds.

When required, peening shall be done immediately after depositing and cleaning each pass of filler metal.

3.5.7 Finished welds shall be thoroughly fused throughout to the base metal. All welding shall have a regular and uniform surface with a minimum of reinforcement and shall be free from injurious defects, especially overlap, undercut, and gas pockets or porosity. Welds shall be 100 percent efficient with full penetration for shell plating, decks, bulkheads, supporting structures, floors, and foundations. When a joint requires welding from both sides, the root of the first weld deposit shall be chipped, ground, or air-arc gouged to sound metal prior to welding the second side of the joint.

3.5.8 Butt joints of steel plating which do not exceed 1/4 inch in thickness may be manually welded without beveling the plate edges. Greater plate thickness shall be beveled to form an included angle of 60 degrees. Root faces shall not be greater than 1/8 inch in depth and the root opening shall not be less than 1/16 inch.

3.5.9 Plug welds or slot welds shall not be used unless specifically authorized.

3.5.10 When the fillet weld size is not specified in AWS B2.1, or listed on the reference drawings, it shall be equal to the thickness of the thinner member being joined.

3.5.11 All welds shall be visually inspected for undercut, lack of penetration, lack of fusion, inadequate blending with base metal surfaces, cracks, crater cracks, and absence of arc strikes.

3.5.12 Aluminum, General:

3.5.12.1 Aluminum shall not be primed or painted before welding.

3.5.12.2 Aluminum surfaces shall be cleaned before welding. If an alkaline detergent is used, rinse the cleaner completely from the aluminum structures. When solvents are used to remove grease or lubricant, only clean wiping rags and stainless steel brushes shall be used with the solvent. Some general cleaning procedures are as follows:

a. To remove oil, grease, moisture, or dust: (1) wipe with hydrocarbon solvent such as acetone or alcohol; (2) wipe with proprietary solvents; or (3) dip edges using one of the above.

b. To remove oxides: (1) dip edges in a strong alkaline solution, then water, then nitric acid, and finish with a water rinse; (2) wipe with proprietary de-oxidizer; or (3) remove mechanically with stainless steel wire brush, file, or grinder. Do not use a lubricant.

3.5.12.3 Aluminum welds will decrease approximately six percent in volume when they cool. Stresses induced by the contraction will cause significant distortion unless allowances are made before welding.

3.5.12.4 Heated aluminum expands nearly twice as much as steel. The heat of welding will cause the un-melted, but heated, parent metal to expand. This expansion adjacent to the weld will reduce the root opening in butt joints during welding. Shrinkage of the weld metal as it cools, coupled with the contraction of the parent metal, may increase crack susceptibility, especially in the weld crater area. Excessive restraint of the sections during cooling shall be avoided to prevent cracks.

3.5.12.5 Aluminum welding wire shall be used as soon as possible after it is removed from the package and a cover should protect spools of wire during use. Welding wire packages with desiccant in plastic bags should remain unopened until ready to be used.

3.5.13 The electrodes used in the welding process must be suitable for the parent metal as approved by regulatory bodies of the U.S. Coast Guard, the American Bureau of Shipping, or the U.S. Navy, or as specifically required within the Detail Specifications. Where dissimilar steels are to be welded, the steel with the higher alloy content shall govern the procedure and electrode to be used. Manual shielded metal-arc electrodes shall be stored in a dry storeroom. Low-hydrogen type electrodes shall be stored and

handled to prevent absorption of moisture into the coating.

3.6 WELDING ARC MARKS - The striking of an arc on any principal hull or deck plate is prohibited unless the plate surface on which the arc is struck is to be incorporated into a welded joint. Marks left by an accidental striking of an arc shall be ground out to a smooth contour taking care that the plate thickness is not reduced by more than ten percent. Removal of arc marks that require a reduction of more than ten percent of the plate thickness shall be reported to the MLCPAC Naval Engineering Support via the Coast Guard Inspector. Any arc strike on HY-80 steel shall be reported to the Coast Guard Inspector.

3.7 GROUNDING FOR ELECTRIC ARC WELDING

3.7.1 To prevent possible serious corrosion damage, compliance with the stray current protection requirements of Appendix B is mandatory for all electric arc welding applications. Pay particular attention to the permissible and prohibited arrangements of Figures B-3 through B-8. Note that the following Appendix B requirements are often overlooked, misunderstood, or misapplied:

3.7.1.1 Return Cables. A minimum of two return cables must be installed, with one normally bonded to the hull as far forward as practicable and the other as far aft. Based upon the total welding current (all operating leads) and the length of the cable run, the nomograph of Figure B-1 shall be used to determine the conductor size of each welding machine return (ground) wire. If other than copper conductors are used, the wire diameter shall be increased to achieve the same overall resistance. The minimum ground conductor size for all applications shall be No. 1 AWG copper or No. 2/0 AWG aluminum. Return cables may be paralleled to meet the minimum cross sectional area requirements and shall be supported to prevent submergence.

3.7.1.2 Grounding. Welding torch leads and return cables shall not be grounded to earth. The frame of a dockside welding machine may be grounded as long as it is insulated (at least 100 kΩ) from all circuits that are electrically connected to the shipboard welding leads.

APPENDIX A
SAFETY REQUIREMENTS FOR WELDING

A.1 FIRE PREVENTION AND CONTROL OF DAMAGE FROM HOT WORK PROCESSES

A.1.1 Scope - This section prescribes general fire prevention precautions for hot work processes onboard ship. For hot work requirements on magazine boundaries, see NAVSEA OP-4, Ammunition Afloat .

A.1.1.1 Hot Work by Private Shipyards - For all commercial shipyard work within the United States, the minimum requirements of CFR Parts 1910 and 1915 apply as federal law. Even when the provisions of this standard are not contractually imposed on commercial activities, the commanding officer still has the ultimate responsibility for ship safety and must ensure that adequate safety precautions are being applied.

a. Fire Watch. One significant difference between this standard and 29CFR Part 1910 is that this standard always requires a fire watch for Class I hot work (welding, cutting, arcing, gouging, thermal spraying and certain grinding operations) whereas 29CFR Part 1910.252(a)(2)(iii) requires a fire watch for welding and cutting where other than a minor fire might develop. This requires a knowledgeable assessment by a work supervisor which includes determining that none of the following conditions exist: (1) Appreciable combustible material, in ship construction or contents, closer than 35 feet (10.7 m), (2) Appreciable combustibles are more than 35 feet (10.7 m) away but are easily ignited by sparks, (3) Wall or floor openings within a 35–foot (10.7 m) radius expose combustible material in adjacent areas including concealed spaces in walls or floors, (4) Combustible materials are adjacent to the opposite side of metal partitions, walls, ceilings, or roofs and are likely to be ignited by conduction or radiation. If all conditions are satisfied, then no fire watch is required. If however, all conditions are not satisfied, then a fire watch is required.

A.1.2 Hot Work

A.1.2.1 Hot Work Definition - Hot work includes:

a. Flame heating, welding, torch cutting, brazing or carbon arc gouging.

b. Any operation which produces temperatures of 400°F (204°C) or higher.

NOTE: Operations not producing hot sparks or flame such as spark-producing or arc producing tools or equipment, static discharge, friction, open flames or embers, impact, and non-explosion-proof equipment such as lights, fixtures, or motors are not considered hot work unless occurring in the presence of flammable liquids or in a flammable atmosphere.

A.1.2.2 Hot Work Classes - Where only class alpha materials (ordinary combustibles) (e.g., wood, cloth, paper, rubber, and many plastics) are exposed, hot work is divided into two classes. These are:

a. Class I. Most Hazardous Class - These processes produce either high energy sparks or slag that can be thrown or dropped at the work site or produce heat that can be transferred through the deck, overhead, bulkhead, or structure to a location not visible to the hot work operator. This class includes:

1 Flame cutting
2 Welding
3 Plasma cutting
4 Arcing and gouging
5 Electric arc welding
6 Thermal spraying
7 Other hot spark or flame producing process not included in Class II

b. Class II. Less Hazardous Class - These processes produce flames or minimal energy sparks or slag which are generally localized to the immediate work area. This class includes:

1 Stud welding with an electric stud gun
2 Gas-tungsten-arc (GTA) welding
3 Torch brazing
4 Ferrous metal grinding with abrasive disks

NOTE: Abrasive disk grinding on non-ferrous material is not included in Class II due to its low energy output.

A.1.3 Fire Prevention Precautions During Hot Work - Any hot work operation can start a fire in combustible materials. It shall be the responsibility of the hot worker and the hot worker's supervisor to take precautions to prevent fires caused by the exposure of combustibles to the effects of hot work.

A.1.3.1 Flammable Liquids and Atmospheres - Do not perform hot work when flammable liquids or flammable atmospheres are present without specific instructions from the Gas Free Engineer.

A.1.3.2 Inspect Far Side - Inspect the other side of the bulkhead, deck, overhead, or other structure to ensure that hot work will not damage materials or equipment that may be on the other side of the hot work operation.

A.1.3.3 Deenergize Equipment - Deenergize all electrical equipment exposed to the hot work.

A.1.3.4 Remove Hazardous Material - Remove explosive materials, flammable liquids, or vapors, and take suitable precautions against the reaccumulation of such materials.

A.1.3.5 Relocate or Protect Combustibles - Where practicable, relocate all combustibles at least 35 feet from the work site. Where relocation is impracticable, protect combustibles with metal or guards and curtains constructed of MIL-C-24576 material. Tighten edges of covers at the deck to prevent sparks from going under the covers. This precaution is also important at overlaps where several covers are used to protect a large pile of combustibles.

A.1.3.6 Protect Equipment - Protect intricate and vulnerable machinery and equipment from falling sparks or other potential sources of fire with metal guards or curtains constructed of MIL-C-24576 material. Secure the protection in place before commencing hot work.

A.1.3.7 Protect Openings - For hot work processes that generate slag, weld splatter or sparks, cover openings in decks, bulkheads or overheads within 35 feet which can be a path to prevent ignition sources from passing into adjacent compartments, spaces or decks below. A complete containment system as described in paragraph A.1.3.7.1 meets this requirement. If the opening cannot be covered, a firewatch shall be posted on the far side.

A.1.3.7.1 A system of containment forms a complete barrier around the work site to prevent hot sparks and weld splatter from coming into contact with combustible materials, using metal guards or curtains constructed of MIL-C-24576 materials. The containment system erected is governed in large measure by the type of hot work being accomplished and the peculiarities of the work site. Containment systems can include one or more of the following:

a. Slag catch basins or pans installed against work area, such as between frames while making hull cuts.

b. Vertically hung curtains erected around the entire hot work area.

c. Raised platforms used in conjunction with vertically hung welders' curtains.

d. Combustibles covered with heavy weight class 1 MIL-C-24576 curtains.

e. Covers over openings, ducts, or cracks in bulkheads or decks which form a part of the containment system to prevent sparks and weld splatter from entering adjacent areas.

A.1.3.8 Protect Ducts - Blank off ducts and conveyor systems that might carry sparks to distant combustibles or otherwise suitably protect.

A.1.3.9 Protect Combustible Construction - When hot work is done near decks, bulkheads, partitions, or overheads of combustible construction, take precautions to prevent ignition.

A.1.3.10 Protect Pipes - Do not undertake hot work on pipes or other metal in contact with insulation or combustible decks, bulkheads, partitions, or overheads if the work is close enough to cause ignition by heat conduction.

A.1.3.11 Notify Ship - Do not start hot work in areas other than those specifically designated for such purposes, such as a welding shop, without approval of the Commanding Officer or designated representative. Abrasive disk grinding with a small wheel (typically three inch diameter or less) does not require notification or approval. Notify the damage control assistant (DCA) or fire marshall before starting hot work. Conduct hot work in or on fuel tanks, in spaces in which fuel tank vents terminate, or in other confined spaces known to contain flammable fuel, only with the Commanding Officer's approval.

A.1.4 Fire Watches - This section prescribes fire watch requirements for most hazardous Class I and less hazardous Class II hot work in way of ordinary combustible materials.

A.1.4.1 Fire Watch Requirements

a. In confined or enclosed spaces, machinery rooms, catapult rooms, bilges, and other locations proximate to flammable atmospheres (e.g., near fuel tank vents and sounding tubes), fire watches shall be posted at the worksite when hot work is undertaken. After completion of the hot work operation, fire watches shall remain on station for a minimum of 30 minutes, ensure that the area is cool to the touch, and ensure that no smoldering embers remain.

b. For Class I hot work, post fire watches when hot work is undertaken. The fire watches shall stand watch for fire for 30 minutes after hot work is completed.

c. For Class II hot work, the DCA or fire marshall shall determine the need for a fire watch in addition to the hot worker, based on his or her assessment of the worksite prior to undertaking hot work. When posted, the fire watch(es) shall stand watch for 30 minutes after hot work is completed.

NOTE: Abrasive disk grinding on a ferrous material with a large wheel (larger than 3-inches in diameter) typically throws large sparks long distances. A fire watch is recommended for large wheel grinding when class alpha materials (ordinary combustibles) are exposed. The DCA or fire marshall shall determine the need for a fire watch.

d. When a fire watch is not required for Class II hot work, the hot worker shall have the appropriate fire extinguishing equipment available. The hot worker may leave the site after hot work is completed and after he/she has conducted a thorough survey of the area to check for smoldering fires. When grinding a ferrous material with a large abrasive disk wheel (larger than 3 inches in diameter), the hot worker shall stand watch for 30 minutes after the hot work ends.

e. When any type of hot work is being performed on bulkheads, decks, or overheads where sparks or heat transfer may ignite combustibles on the opposite, accessible side, set a fire watch on the far side.

f. The hot worker and the hot worker's supervisor are responsible for ensuring fire watches are in place prior to starting work.

g. Train fire watches per paragraph A.1.4.2.

h. Equip fire watches with personal protective equipment (PPE) as required for the operation being conducted (e.g., appropriate eye protection (goggles, glasses, face shield), helmet, respiratory protection, fire retardant clothing).

i. When more than one fire watch is required, establish a communication means between fire watches.

j. A single fire watch may provide protection where several hot workers are performing hot work in a single work area with the following limitations:

1. The fire watch must be within fifty feet of all hot work operations and have an unobstructed view, without turning, of all hot work operations and exposed areas from a single fixed location at which he is stationed and have no physical obstructions or barriers that would prevent immediate access by the fire watch to the hot work operation should a fire occur.
2. No more than four hot workers shall be attended by single fire watch.
3. The fire watch cannot rove from one compartment/area to another in carrying out his duties as a fire watch in a way which would affect the requirement of maintaining a continuous line of sight view of all hot work.
4. A means of communicating between the fire watch and all hot workers shall be provided such that in the event of a fire, the fire watch can immediately notify all hot workers to stop operations.

A.1.4.2 Fire Watch Training - Fire watches shall be adequately trained. An adequately trained fire watch shall:

a. Know how to determine if an extinguisher is fully charged and properly sealed.

b. Know the different classes of fires as defined. There are four classifications of fire: Class A, Class B, Class C, and Class D. The different classifications are briefly described in the following paragraphs.

1. Class A Fires - Class A fires involve wood and wood products, cloth, textiles and fibrous materials, paper and paper products. Class A fires are extinguished with water in straight or fog pattern. If the fire is deep-seated, aqueous film forming foam (AFFF) is more effective than seawater and can be used as a wetting agent to rapidly penetrate and extinguish the fire.
2. Class B Fires - Class B fires involve flammable liquids such as gasoline, diesel fuel (F-76), jet fuels, hydraulic fluid, and lube oil. These fires are normally extinguished with AFFF, Halon 1211, Halon 1301 or potassium bicarbonate (PKP). Class B fires also involve flammable gases which should never be extinguished unless there is reasonable certainty that the flow of gas can be secured. Securing the fuel source is the single most important step in controlling a gas fire.
3. Class C Fires - Class C fires are energized electrical fires that are attacked at prescribed distances using nonconductive agents such as CO_2 , Halon 1211 or water spray. The most effective tactic is to de-energize and handle the fire as a Class A fire. When fires are not deep seated, clean agents that pose no cleanup problem such as Halon 1211 or CO_2 are preferred.
4. Class D Fires - Class D fires involve combustible metals such as magnesium and titanium. Water in quantity, using fog patterns, is the recommended agent. When water is applied to burning Class D materials, there may be small explosions. The firefighter should apply water

from a safe distance or from behind shelter. Metal fires on board ship are commonly associated with aircraft wheel structures.

c. Know the type of extinguishing agent that is effective on each class of fire.

d. Know procedures and use associated with personnel protection equipment. Normally, such equipment is provided for eye and breathing protection.

e. Demonstrate ability to operate an extinguisher on both a flammable liquid and ordinary combustible type fire.

f. Know that the hot worker and the hot worker's supervisor are responsible for inspecting all sides of a bulkhead or deck, ensuring that combustibles are removed to a safe distance from the hot work and ensuring the physical placement of the fire watch.

g. Know that he and the hot worker shall ensure that openings and combustible material that cannot be removed shall be covered and protected with fire retardant coverings.

h. Know how he will signal the hot worker in the event of a fire.

i. Know that he is to report an alarm to the Officer Of the Deck (OOD) at the quarterdeck if a fire occurs beyond his capability to extinguish.

j. Know how to transmit an alarm by using the shipyard fire alarm systems or the ship's interior communication system.

k. Know the designation and the location of the compartment in which he is standing watch and that he is responsible for leading ship's force back to the fire if requested.

l. Know that before securing the watch, he shall stand 30 minutes at the hot work site after hot work has been completed. m. Know the procedures for confinement of hot work including use of welder's curtains.

n. Be familiar with hot work permit system in effect and what the system is intended to accomplish and who will monitor performance.

o. Know personnel qualification standards according to Naval Education and Training publication NAVEDTRA 43119 (Series) Personnel Qualification Standard for Damage Control.

A.1.5 Fire Extinguishing Equipment For Fire Watches - Maintain suitable fire extinguishing equipment of approved types near all hot work operations. Judge the suitability of the equipment by an analysis of the conditions at the scene of operations. Where small amounts of ordinary combustible (class A) materials are the predominant material which could burn, water or aqueous film forming foam (AFFF) fire extinguishers are superior to carbon dioxide (CO_2). Portable 2.5 gallon pressurized water extinguishers (NSN 9C 4210-00-720-1815) are available through the supply system. Carbon dioxide extinguishers are preferable for electrical cables or equipment (class C) fires. In a small space, with a very small access opening, however, the operator may not be able to get out quickly in case of fire, and the use of carbon dioxide will be injurious to him. Under such conditions, use of water spray from a 1-1/2 inch fog nozzle would be preferable. In all cases a 1-1/2 inch fog nozzle shall be available as a backup to other equipment. Carbon-tetrachloride extinguishers shall not be used.

A.1.6 Not Used

A.1.7 Additional Requirements For Hotwork In Way Of Acoustic Insulation With Septum Material - Fires started by hot work have occurred onboard ships with acoustic insulation and septum material. All fires in the septum material were concealed by the outer insulation, smoldered and went undetected for many

hours. The insulation is typically four inches thick consisting of layers of two-inch thick fiberglass with a flexible sheet of septum barrier usually sandwiched in the middle. Septum barriers used onboard ship are sheets of lead loaded vinyl, barium sulfate loaded vinyl or barium sulfate loaded silicone and vary in thickness from 1/16 to 1/8 inch. The septum material is visible when insulation is stripped away in preparation for hot work. Special attention should be given to protecting septum from hot work. Where identification of the material is questionable, sampling and analysis may be necessary.

a. The following procedures should be followed for welding operations:

1 Prior to performing welding, all acoustic insulation shall be removed a minimum of twelve inches from the point of hot work (both near side and far side). Place two layers of welders curtain (NSN 8305–01–0335–1058 or equal) over the exposed edges and attach to the bulkhead with two-inch strips of duct tape or equivalent. Once all of the cloth is securely fastened, cover all duct tape with a minimum of two layers of 3M heat resistant tape, Part # 361 or equivalent. See Figure A–1.

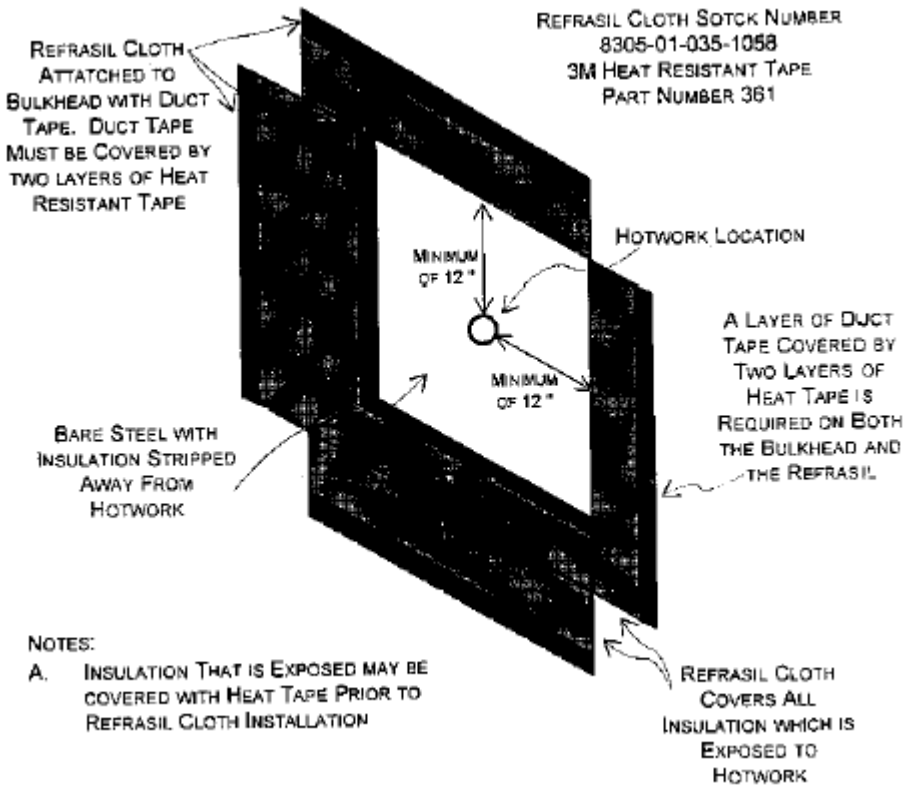


Figure A-1. Site Preparation for Welding on Bulkhead Insulated With Acoustic Insulation and Septum Material

2 Remove insulation between ship frames if insulation is less than 12 inches from the hot work site. The insulation on the frame face shall also be removed. Any exposed insulation shall be covered.

3 When performing hot work operations where bulkheads, decks and overheads covered with acoustic insulation are at risk, cover with welders curtain.

4 Fire watches shall be equipped with portable 2–1/2 gallon water or AFFF fire extinguishers or a minimum of a 3/4 inch (ID) charged hose with fog nozzle (supplied from a freshwater source for submarines).

5 During hot work, the protective covering shall be closely monitored for any signs of burning.

Extinguish all fires with water or a water-based extinguishing agent such as AFFF.

6 Upon completion of the hot work operation, remove the entire protective covering and inspect the insulation and septum for any signs of burning or smoldering. Inspection of the insulation and septum material shall continue for a 30 minute surveillance period, concluding that no smoldering or burning materials remain. Insulation should be cool to the touch.

b. For all Class I hot work other than welding, added precautions to those listed above must be taken to prevent molten slag and metal from contacting the external surface of the insulation. One approach is to remove all insulation in way of the operation. Other alternatives include: installing a containment system by tack welding metal strips around the cut thus providing a "shelf" on all sides extending beyond the insulation thickness.

A.2 WORKING WITH ARC WELDING EQUIPMENT - When work in a restricted access space is to be suspended for any substantial period of time, such as during lunch, overnight, or for drills, all electrodes shall be removed from the holders. If work is to be suspended for a period of 1 hour or more, one of the following precautions shall be taken:

a. All arc welding equipment shall be removed from the restricted access space.

b. All arc welding equipment shall be disconnected from the power source. This shall always be done when the equipment is to be left overnight.

c. All arc welding equipment, including the electrode holder, shall be positively insulated so that no accidental contacts can be made, even if the equipment is moved during this period.

A.3 WORKING WITH OXYFUEL OR INERT GAS WELDING, CUTTING, AND BRAZING EQUIPMENT - To eliminate the possibility of gases escaping through leaks or improperly closed valves, torch valves shall be closed and the gas supply to the torch positively shut off at some point outside the confined area. The precaution does not apply to shop spaces in which active stowage of welding equipment has been authorized. Oxygen (fuel) or inert gas torches shall remain in restricted access spaces only for the period necessary to perform the actual torch operations. Oxygen (fuel) or inert gas torches not attended during periods such as lunch, drills, or overnight shall be removed from restricted access spaces or the oxygen (fuel) or inert gas shall be shut off and the hoses disconnected at the supply connection.

Table A-1. Eye Protection Lens Shade Guidelines

Welding Operations	Shade Number
Shielded Metal-Arc Welding - 1/16, 3/32, 1/8, 5/32-inch electrodes	10
Inert-Gas Metal-Arc Welding - (Nonferrous) 1/16, 3/32, 1/8, 5/32-inch electrodes	11
Inert-Gas Metal-Arc Welding - (Ferrous) 1/16, 3/32, 1/8, 5/32-inch electrodes	12
Shielded Metal-Arc Welding - 3/16, 7/32, 1/4-inch electrodes	12
Shielded Metal-Arc Welding - 5/16, 3/8-inch electrodes	14
Arc-Air Cutting and Gouging	12-14
Soldering	2
Torch Brazing	3-4
Light Cutting, up to 1 inch	3-4
Medium Cutting, 1 inch to 6 inches	4-5
Heavy Cutting, 6 inches and over	5-6
Gas Welding (Light), up to 1/8 inch	4-5
Gas Welding (Medium), 1/8 inch to 1/2 inch	5-6
Gas Welding (Heavy), 1/2 inch and over	6-8

APPENDIX B
STRAY CURRENT PROTECTION

B.1 UNDERWATER CORROSION

B.1.1 Underwater hull and shaft corrosion is, in large part, directly attributable to improper hookup of welding leads while work is being performed on ships which are waterborne. Corrosion resulting from improper weld lead hookup is induced through electrolytic action by stray electrical currents.

B.1.2 Corrosion of a ship hull may result from other sources of direct currents. If a grounded neutral leg of a three-wire direct current system, used to supply power to the ship, is grounded permanently or accidentally on the ship, current flow will result.

B.2 CURRENT FLOW

B.2.1 Current flow is caused by the difference in electrical potential between any two localities. Even though the path through water offers greater resistance to current flow than adjoining electric ground cable, water still will carry a fraction of the current and create an undesirable condition.

B.3 WELDING EQUIPMENT REQUIREMENTS

B.3.1 To prevent possible serious damage to electrical and ordnance equipment, and pitting of ship structure, the requirements for welding on ships, both waterborne and in dry or floating docks, shall be used. The requirements are:

a. Each ship shall have a separate welding current power source.

b. Return cable of any welding generator shall never be grounded to anything but the ship the cable is servicing.

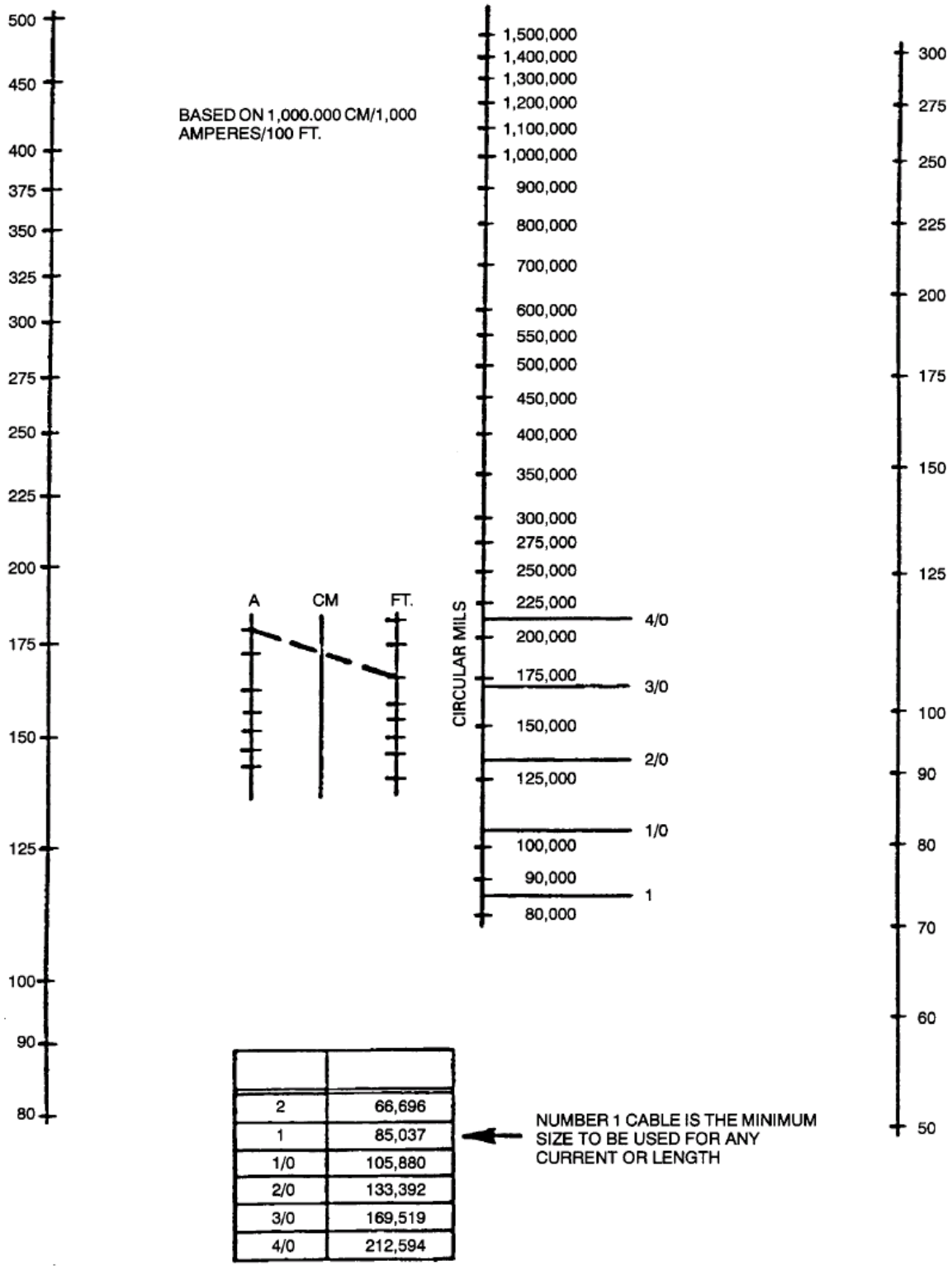
c. The welding cable used in each welding circuit, both in the electrode and in the ground or return side of the circuit, shall be completely insulated, and not permitted to drop overboard into the water.

d. The frame or case of the welding machine, except engine-driven types, shall be grounded according to the methods prescribed in the National Electrical Code (primary side).

B.4 GROUNDING CONNECTIONS

B.4.1 Cable Lugs - Grounding cable lugs shall be secured tightly to grounding plates. The lug contact area shall be cleaned thoroughly to base metal. Resistance of the connection shall be a maximum of 125 microhms (μΩ) for each connection; voltage drop across the connection shall be a maximum of 62.5 millivolts (mV) for a current of 500 amperes (A). Use Ohm's law (V = IR) to determine voltage drop for currents other than 500 A.

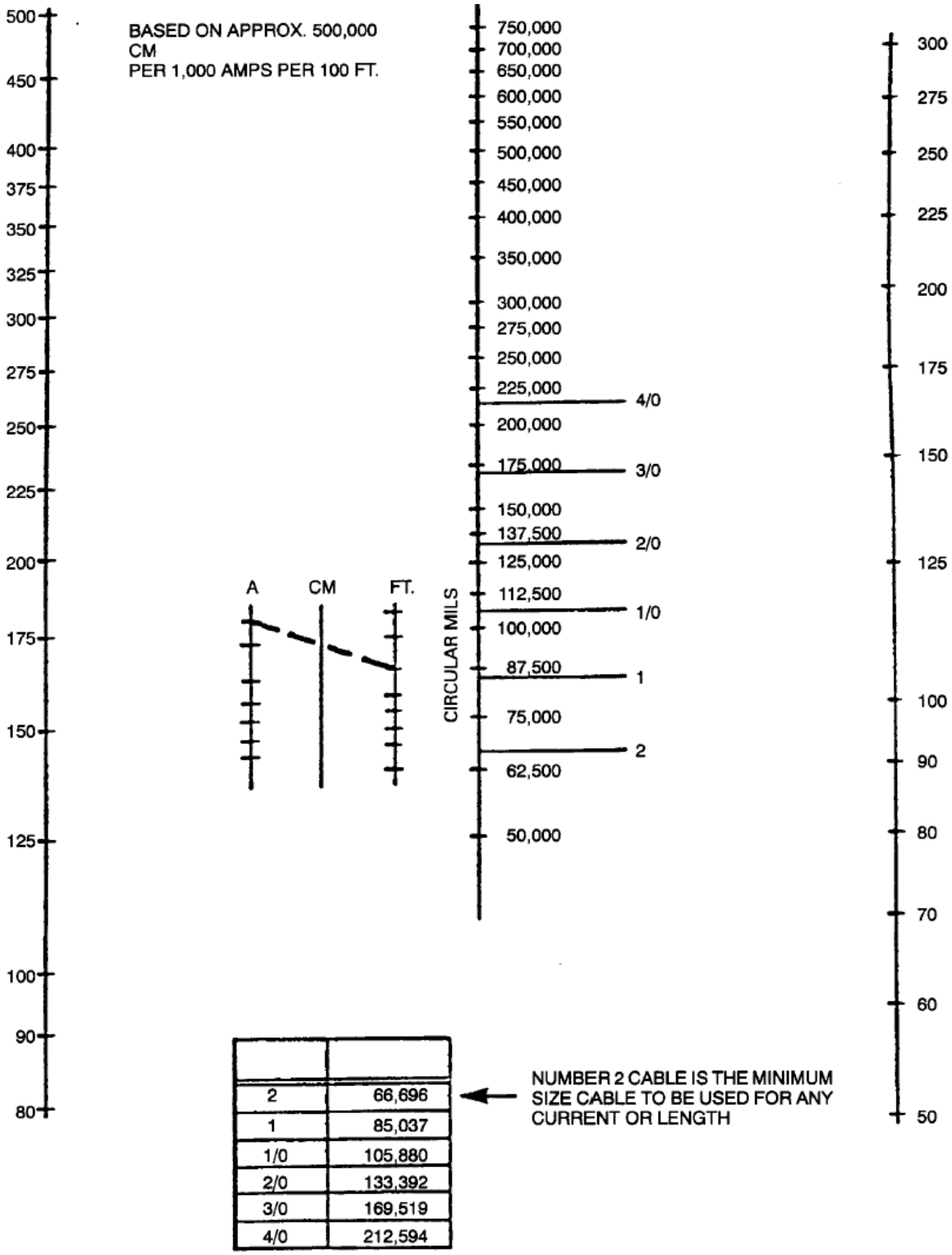
B.4.2 Cable Size - Cross-sectional areas of return ground cable should be one million circular mils minimum for each 1,000 A for each 100 feet. One or more cables, connected in parallel, may be used to meet the minimum cross-sectional area requirements. A nomograph showing required cable size for ground return leads is presented in Figure B-1.



2	66,696
1	85,037
1/0	105,880
2/0	133,392
3/0	169,519
4/0	212,594

Figure B-1. Nomograph for Copper Ground Wire Size

B.4.2.1 Manufacturers' recommendations for electrode lead cable size shall be used. Lead cable size is approximately 500,000 circular mils for each 1,000 A for each 100 feet. A nomograph showing copper electrode lead cable size is presented in Figure B-2.



2	66,696
1	85,037
1/0	105,880
2/0	133,392
3/0	169,519
4/0	212,594

Figure B-2. Nomograph for Copper Electrode Lead Cable Size

B.4.3 Resistance - Resistance between welding ground cable and the welding machine case should not be less than 0.1 megohms (MΩ) when the machine is not connected to the ship. Resistance less than 0.1 megohms will indicate improper insulation of ground cable, or a need to clean the welding machine.

B.5 WELDING UNIT ARRANGEMENTS

B.5.1 Combinations of welding unit arrangements with correct and incorrect grounding connections are shown in Figure B-3, Figure B-4, Figure B-5, Figure B-6 and Figure B-7. These figures represent common arrangements and errors in making welding machine connections.

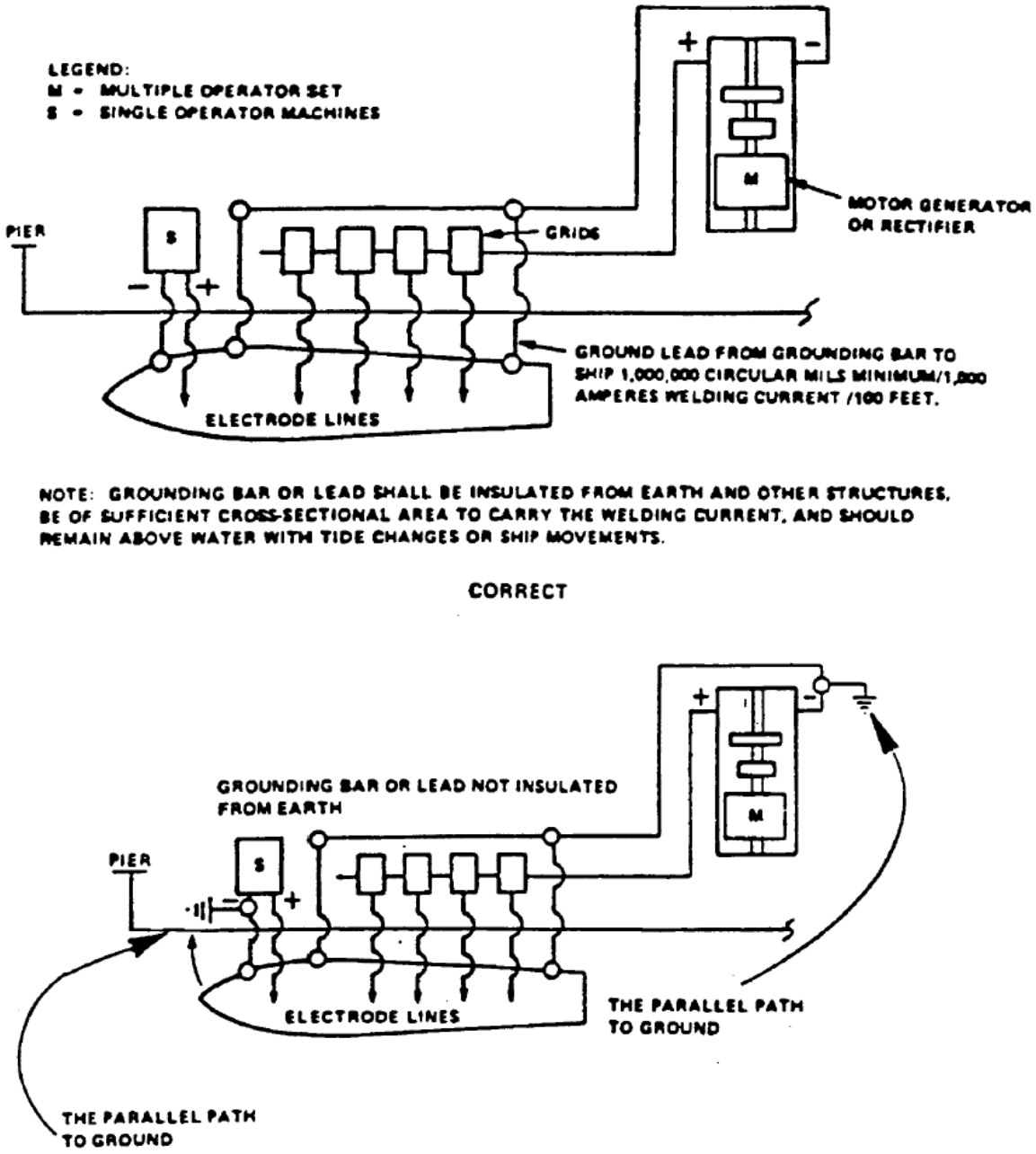
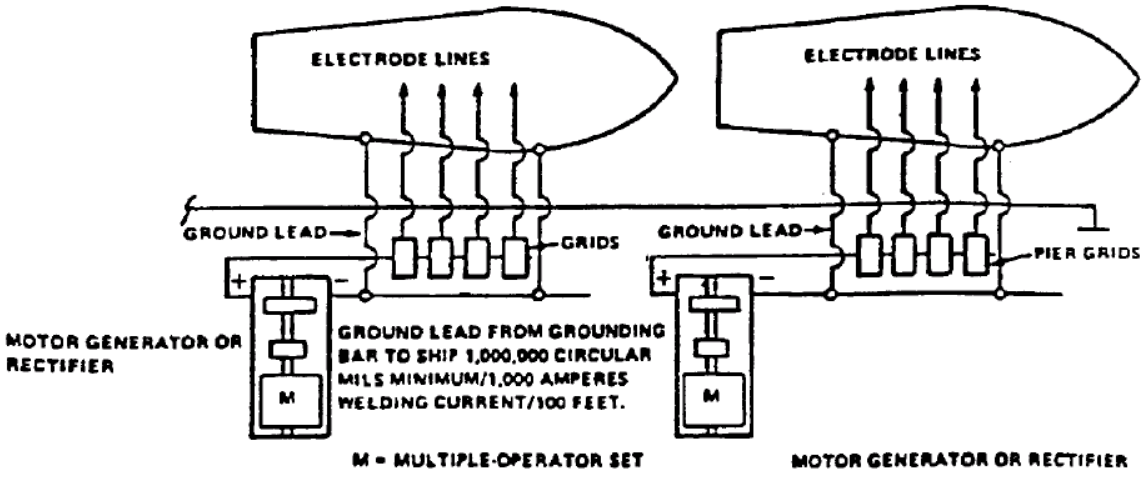
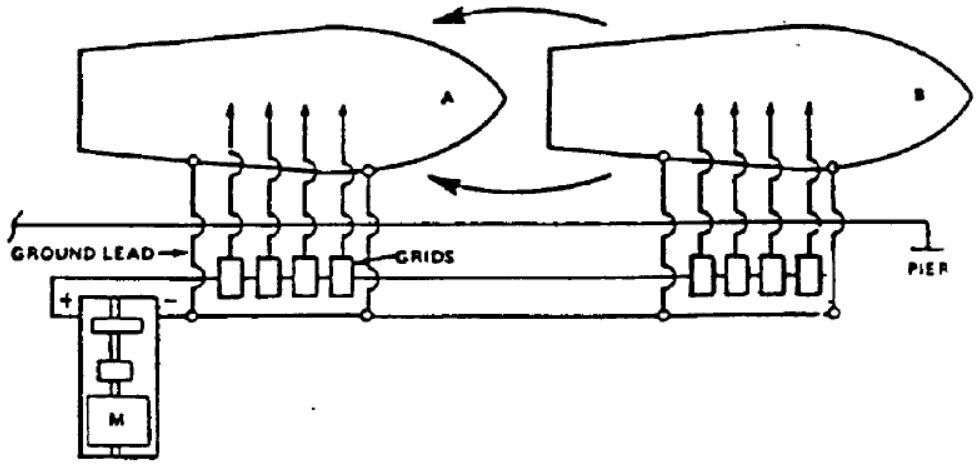


Figure B-3. Hookup for Single Ship at Pier



NOTE: WELDING ON TWO OR MORE SHIPS (IN CASE OF MULTIPLE-OPERATOR MACHINE) SHOULD NOT BE PERFORMED WITH THE SAME GENERATOR OR RECTIFIER.

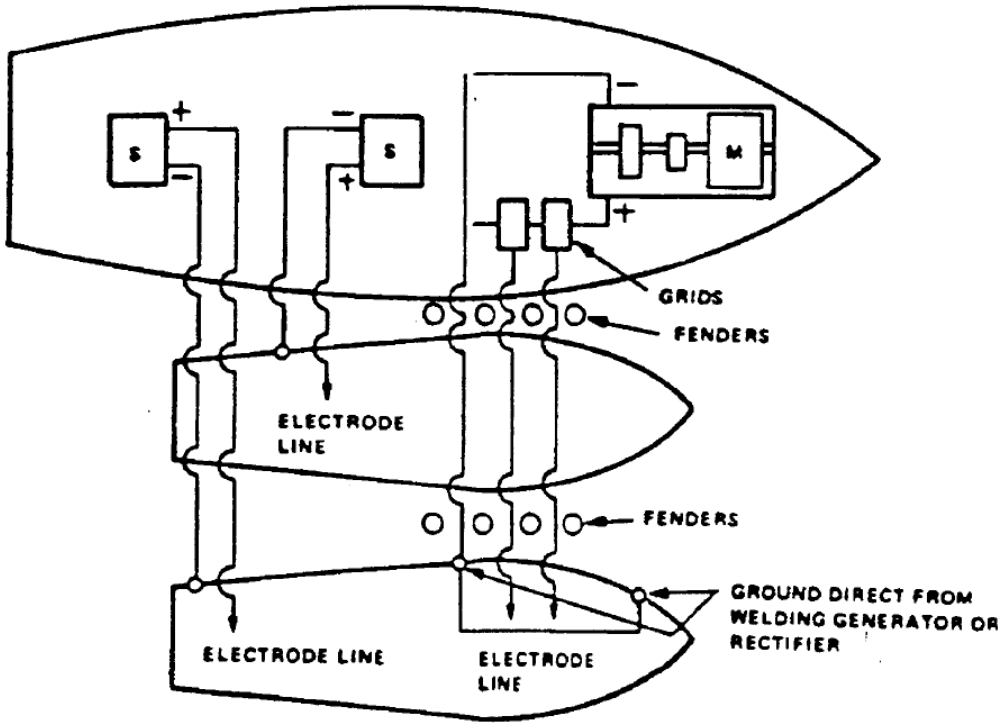
CORRECT



NOTE: WHEN TWO SHIPS ARE CONNECTED TO THE SAME GENERATOR OR RECTIFIER, THE RESISTANCE OF THE NEGATIVE RETURN BETWEEN THE SHIPS CANNOT BE MADE LOW IN COMPARISON WITH THE RESISTANCE THROUGH THE WATER. SOME OF THE CURRENT USED ON SHIP B FLOWS THROUGH THE WATER, CORRODING METAL OFF SHIP B AND POSSIBLY BLISTERING PAINT ON SHIP A.

INCORRECT

Figure B-4. Hookup for Two Ships at Pier



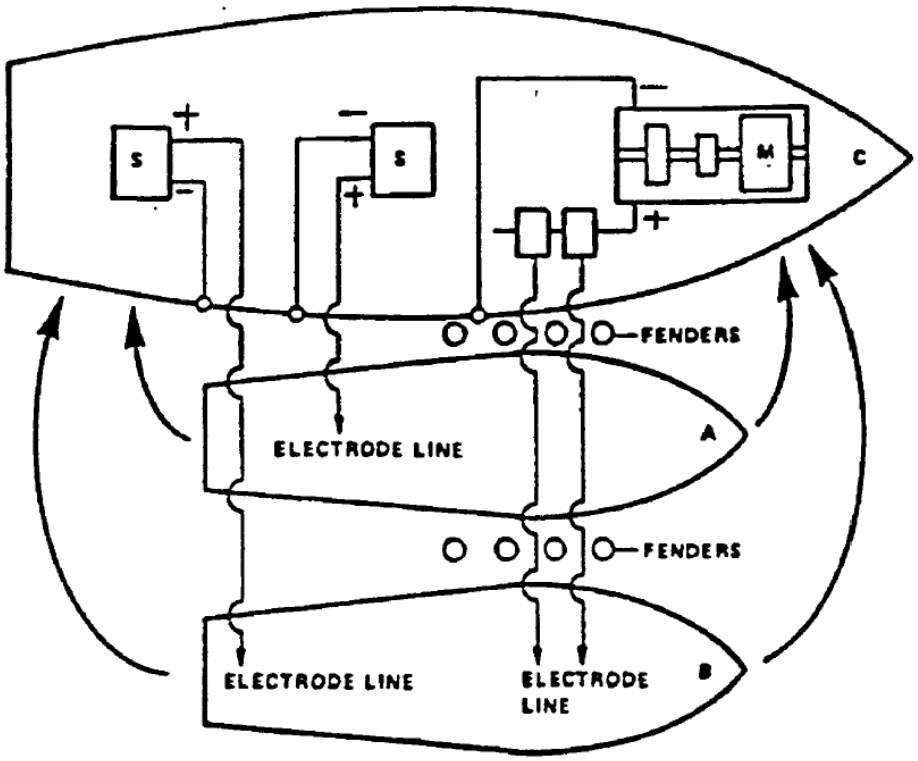
LEGEND. M = MULTIPLE-OPERATOR SET
S = SINGLE-OPERATOR SET

NOTES

1. FOR SINGLE OPERATOR MACHINES, ATTACH THE GROUND LEAD AS CLOSE AS PRACTICAL TO STRUCTURE OR COMPONENT TO BE WELDED.
2. WELDING ON TWO OR MORE SHIPS (IN CASE OF A MULTIPLE-OPERATOR MACHINE) SHOULD NOT BE PERFORMED WITH THE SAME GENERATOR OR RECTIFIER.

CORRECT

Figure B-5. Hookup for Ships Afloat (Sheet 1 of 2)



LEGEND: M = MULTIPLE-OPERATOR SET
S = SINGLE-OPERATOR SET

NOTE. WHEN THE GENERATOR OR RECTIFIER ON ONE SHIP GROUNDED TO THAT SHIP IS USED TO WELD ON ANOTHER SHIP WHICH IS WITHOUT A GROUND OR IS IMPROPERLY GROUNDED, ALL OR PART OF THE WELDING CURRENT RETURNS FROM SHIPS A AND B TO SHIP C THROUGH THE WATER.

INCORRECT

Figure B-5. Hookup for Ships Afloat (Sheet 2 of 2)

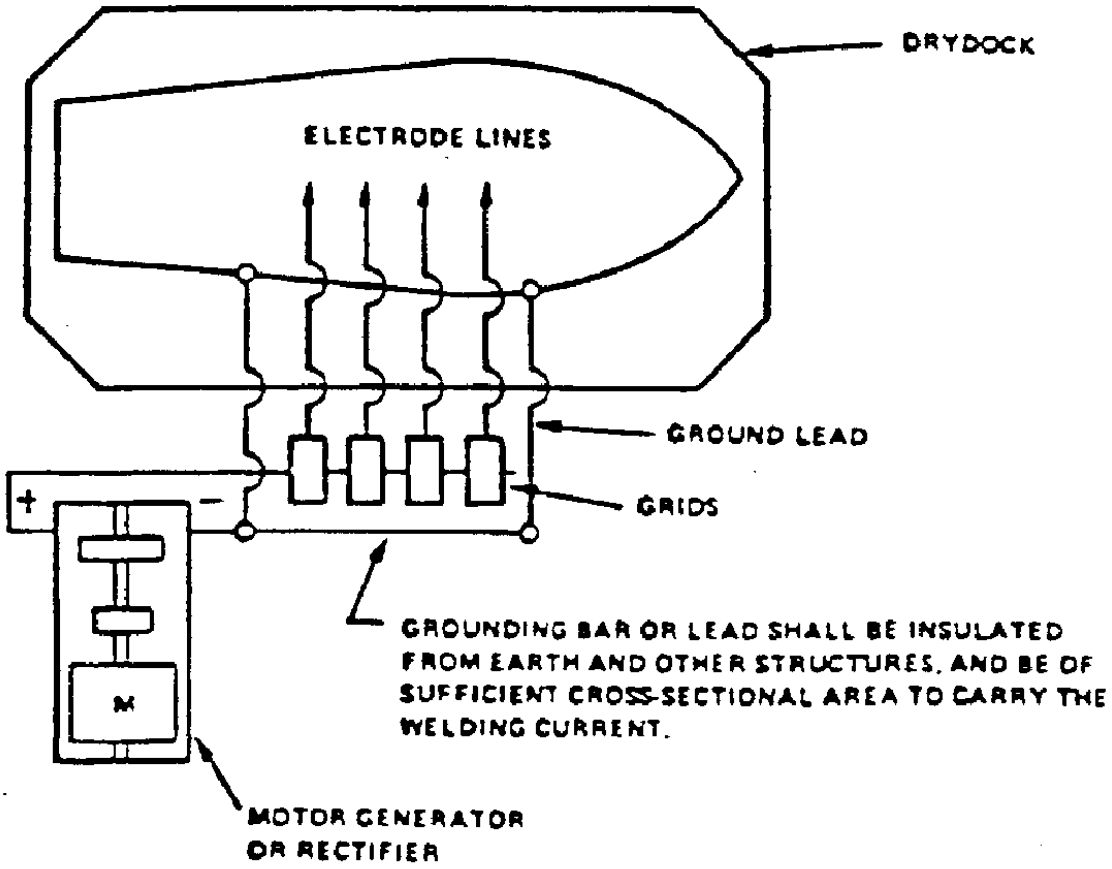


Figure B-6. Hookup for Ship in Floating Docks

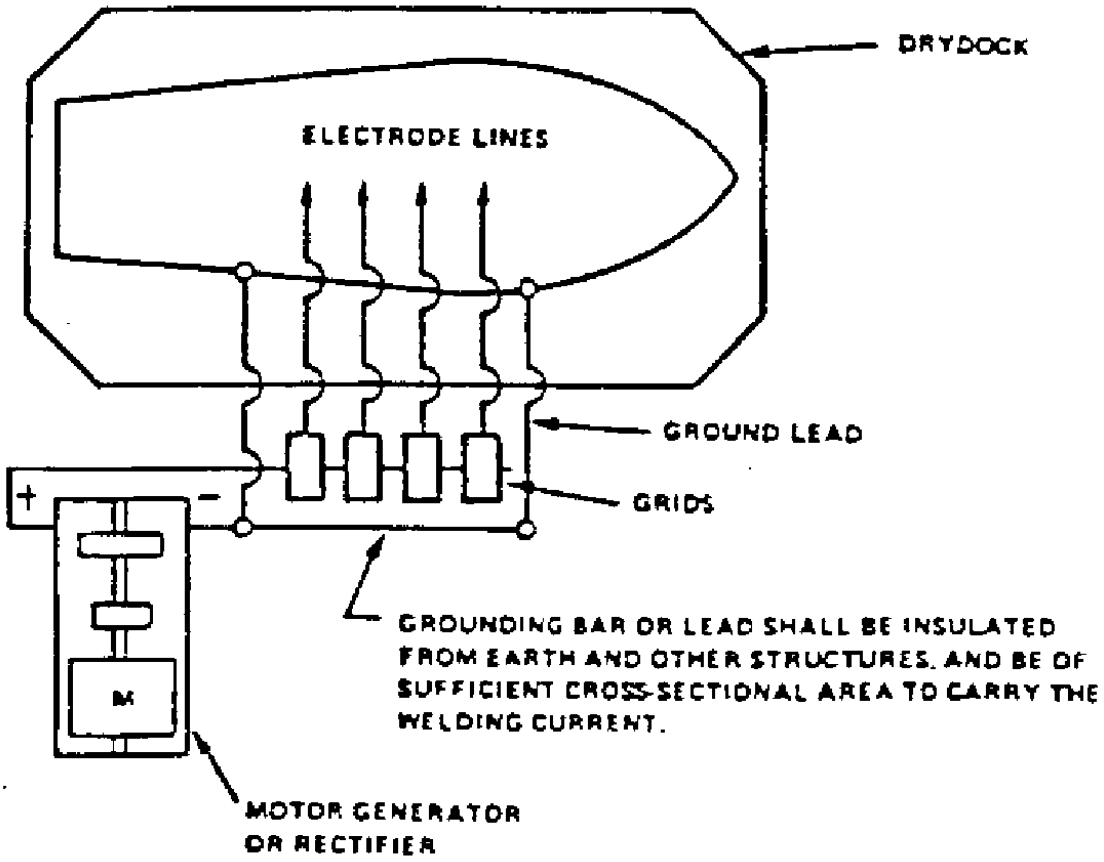
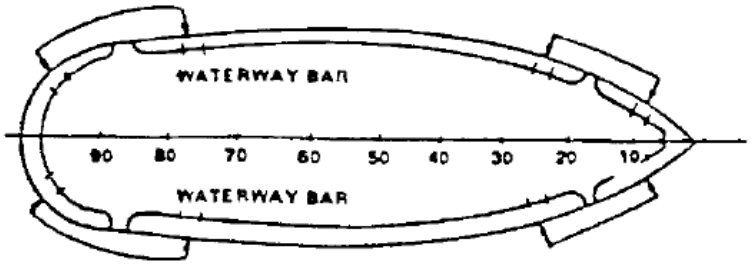


Figure B-7. Hookup for Ships in Dry or Graving Dock

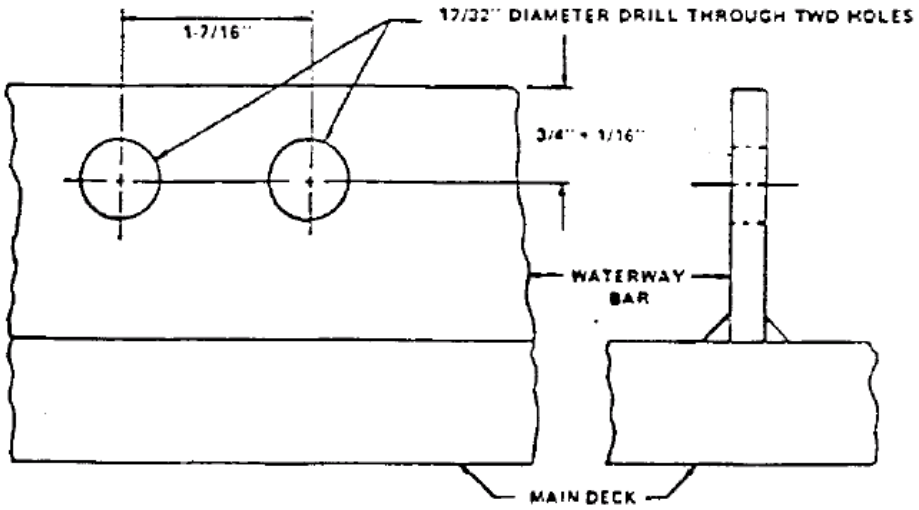
B.5.2 Details for making provisions for welding grounding connections on steel surface ships are shown in Figure B-8.



MAIN DECK STEEL HULL

NOTES:

1. LOCATE HOLES IN AREAS INDICATED BY ARROWS.
2. ON STEEL HULLS WITH NO WATERWAY BAR, DRILL HOLES IN DECK COAMINGS.
3. CLEAN LUG CONTACT AREA TO BARE METAL WHEN GROUNDING CONNECTIONS ARE MADE. (WHEN GROUNDS ARE BROKEN, THE AREA SHALL BE PAINTED TO MATCH THE SURROUNDING DECK.)
4. WITHIN 6 INCHES OF LUG CONTACT AREA, PAINT IN BLACK, 3/4-INCH-HIGH LETTERS: GROUNDING CONNECTION AREA.



TYPICAL HOLE SPACING GROUNDING LUG ATTACHMENT

NOTES:

1. HOLES ARE TO BE DRILLED AT LOCATIONS SHOWN ABOVE.
2. WHERE POSSIBLE, MODIFY AND UTILIZE EXISTING HOLES IN WATERWAY BARS.

Figure B-8. Grounding Connections on Steel Surface Ships

B.6 SPECIAL PRECAUTIONS

B.6.1 General - For welding on or near electrical equipment, machinery, or ordnance equipment, special precautions shall be observed. Precautions listed in paragraphs B.6.2 through B.6.5 shall be followed for welding equipment electrical connections when welding on or near electrical or loaded ordnance equipment.

B.6.2 Welding Current - The static grounding straps on electrical equipment, machinery, and ordnance equipment have not been designed, and shall not be used, as welding ground returns. Welding current shall not be allowed to pass through bearings (ball, roller, or bushing type) to return to grounds such as gun mounts, motors, and lathes.

B.6.3 Splitting Ground Return Cables - When welding on piping that leads into loaded ordnance equipment areas, ground return cables should be split into two equal conductors so that one run is connected to the pipe on each side of the welding area, and located as close to the area as possible. If pipe hangers or branch pipes are located between the dual ground connections, provide additional split ground connections to such items. A maximum distance of 10 feet should be maintained between connectors and work. See ANSI/ASC Z49.1, Safety in Welding and Cutting, for additional restrictions.

B.6.4 Resistance Checks - Ensure the adequacy of each ground return cable connection between the ship's hull and power source by checking the resistance of each connection. The maximum permissible resistance shall be 125 microhms for each connection, or the voltage drop across the connection should be a maximum of 25 millivolts (mV) for a current of 200 A.

B.6.4.1 Ensure that ground return cables are adequate for amperage and distance involved (see Figure B-1).

B.6.4.2 Precautionary measures outlined in manufacturers' equipment manuals and other documents should be observed when welding on or near electrical equipment. Often control cables must be disconnected and sensitive electronic equipment removed from platforms equipped with electronic engine control systems. These measures should be observed because the induced magnetic field produced by welding may damage electrical equipment.

B.6.5 Location Of Ground Return Cables - When systems such as piping, pressure vessels, or machinery are being welded, the ground return cable connection should be located as close to the work as possible. This ensures that welding current does not flow through bearings, threaded joints, and other areas where arcing could occur. Ground return cable connection should be no farther than 10 feet from work.